Space Weather Technical Forecast

Issued on Sunday, 12 March 2023 at 01:09 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated M-class flares (R1-R2/Minor-Moderate radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the last 24 hours with generally background C-class activity. The largest flare a C4.9 at 11/0103UTC from AR3245. There are currently 10 numbered sunspots on the visible disc, with AR3245 the largest region, although has shown little growth. The remaining regions are generally small or magnetically simple, and either stable or slowly evolving. However, AR3250 has shown some consolidation in the trailing portion of the region. A new and currently unnumbered region has emerged to the south of AR3250. A coronal mass ejection (CME) associated with a filament eruption off the southwest quadrant observed at 10/1700 UTC has been analysed and is likely to give a glancing blow at Earth on either late on the day 3 (14 Mar) or early day 4 (15 Mar). Another large filament eruption was observed lifting off the southwest quadrant at 11/1648 UTC, which produced a CME. This has been analysed for any Earth-directed component, although currently awaiting the results. No other Earth-directed CMEs have been observed in coronagraph imagery.

Solar Wind / Geomagnetic Activity: The solar wind reached a peak of 474 km/s at 11/0830 UTC, before a steady decline towards the current slow-ambient levels, near 390km/s. Density has been mostly below average, with steady rise towards average by end of period. Total magnetic field strength was weak around 5-7nT. The north-south component varied weakly between negative and positive levels. Phi angle was generally negative (towards the Sun) but with occasional periods of positive. Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 remained at background levels. High energy electron flux (greater than 2MeV) has been at moderate levels, with a peak of 956pfu at 11/2010 UTC. Electron fluence has been mostly steady following a slightly declining trend. A reading of 2.07e7 was observed at 12/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain generally Low with occasional C-class flares. But with the number of active regions on the disc there remains a chance of an isolated M-class flare, perhaps most likely from AR3245 or the developing AR3250.

Solar Wind / Geomagnetic Activity: Solar winds are expected to be at mainly slow-ambient levels over the coming days, with no further coronal hole HSS connections forecast, to give appreciable enhancements. The next enhancement is likely to be late on day 4 (15 Mar) with a HSS from CH84/+, with solar winds likely to reach around 500km/s. Geomagnetic activity is likely to be mostly Quiet to Unsettled (Kp 0-3) throughout the period, with a slight chance of Active intervals, with any glancing blow from a CME (on 15 Mar) and the arrival of the next HSS from CH84.

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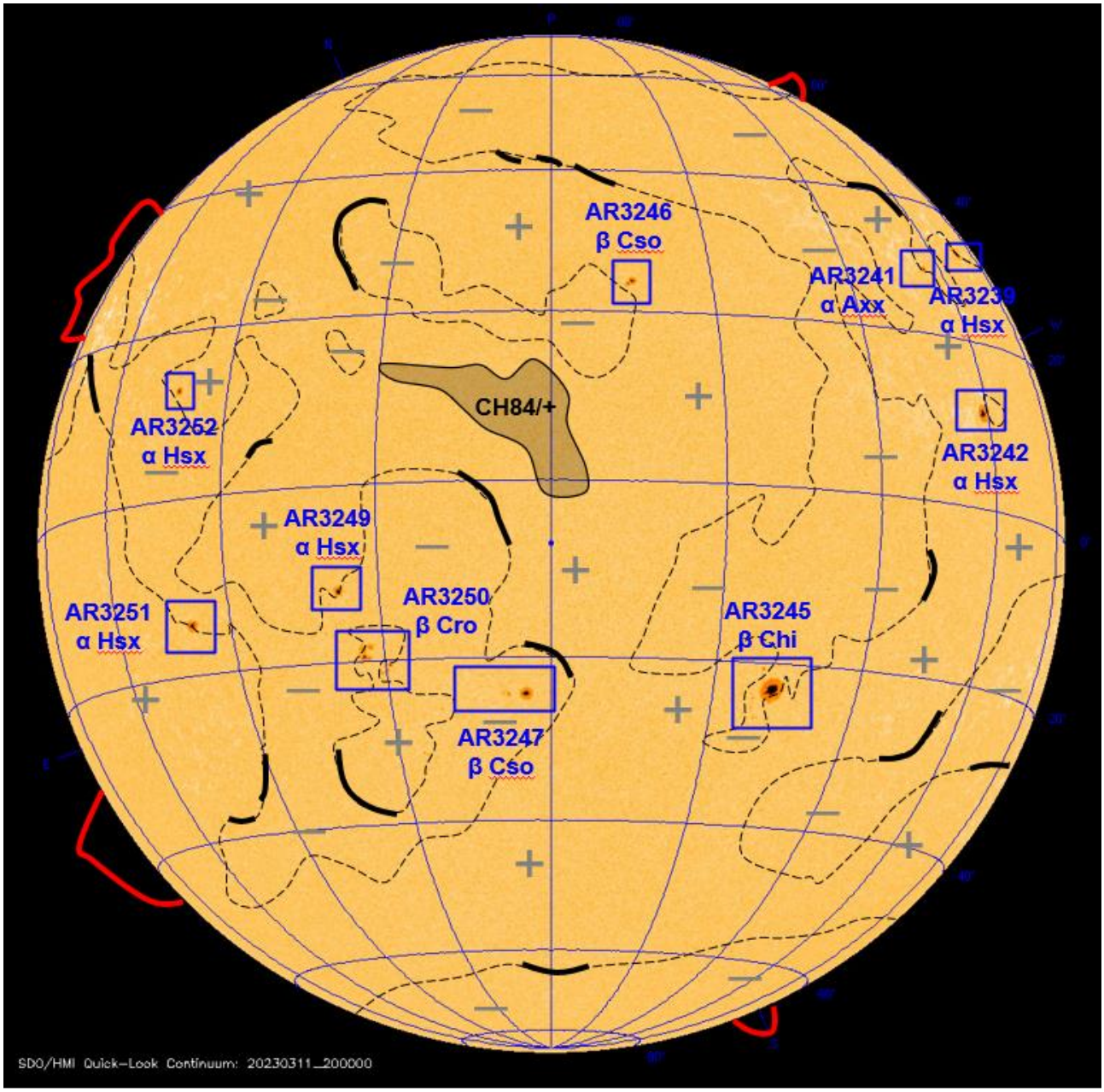
Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux, as observed by GOES16, is currently at background levels with a slight chance of reaching S1 or greater should any larger flares occur. High energy electron flux levels (greater than 2MeV) are expected oscillate between moderate and high levels initially, becoming mostly background to moderate. Electron fluence is expected to continue to slowly decline and probably remain below the Active threshold.

Figure 1. Solar Analysis Valid 11/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Coronal hole influence has weakened with solar winds now at slow-ambient levels. No further coronal holes are expected to affect the Earth through much of the forecast period, however positive region CH84 is due to arrive in a favourable location with a high speed stream probably reaching Earth late on day 4 (15 March). A coronal mass ejection (CME) associated with a filament eruption off the southwest quadrant observed at 10/1700 UTC has been analysed and is likely to give a glancing blow at Earth either late on day 3 (14 Mar) or early day 4 (15 Mar). Another large filament eruption was observed lifting off the southwest quadrant at 11/1630 UTC, which produced a CME. This has been analysed for any Earth-directed component, although currently awaiting the results. No other Earth-directed have been observed in coronagraph imagery.

Geomagnetic activity is likely to be mostly Quiet to Unsettled (Kp 0-3) throughout the period, with a slight chance of Active intervals, with any glancing blow from a CME and the arrival of the next HSS from CH84 towards the end of the period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	5	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Possible glancing blow from a CME on day 4 (15th March) – low confidence.

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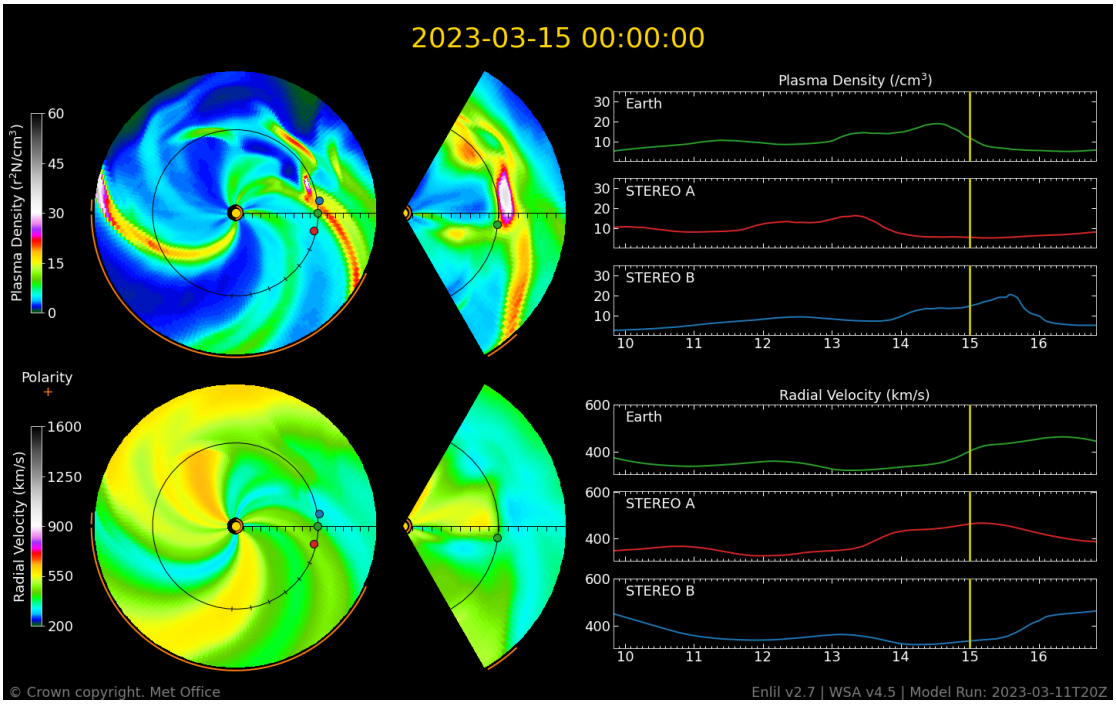
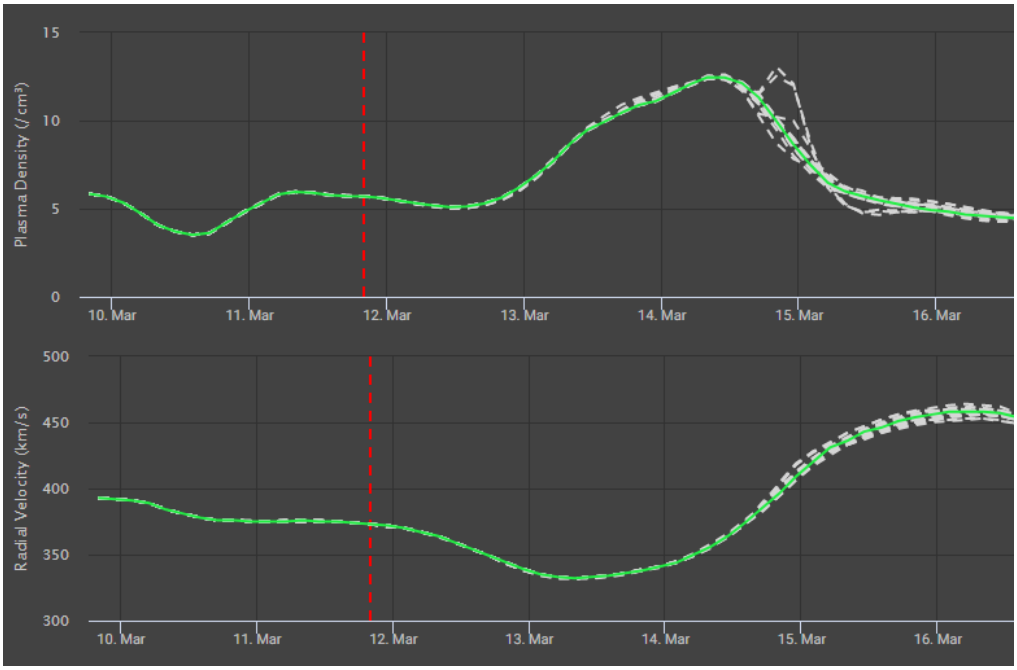
Figure 2: MOSWOC ENLIL (top) and Ensemble (bottom) shows a possible glancing blow from a CME around the 15th March.





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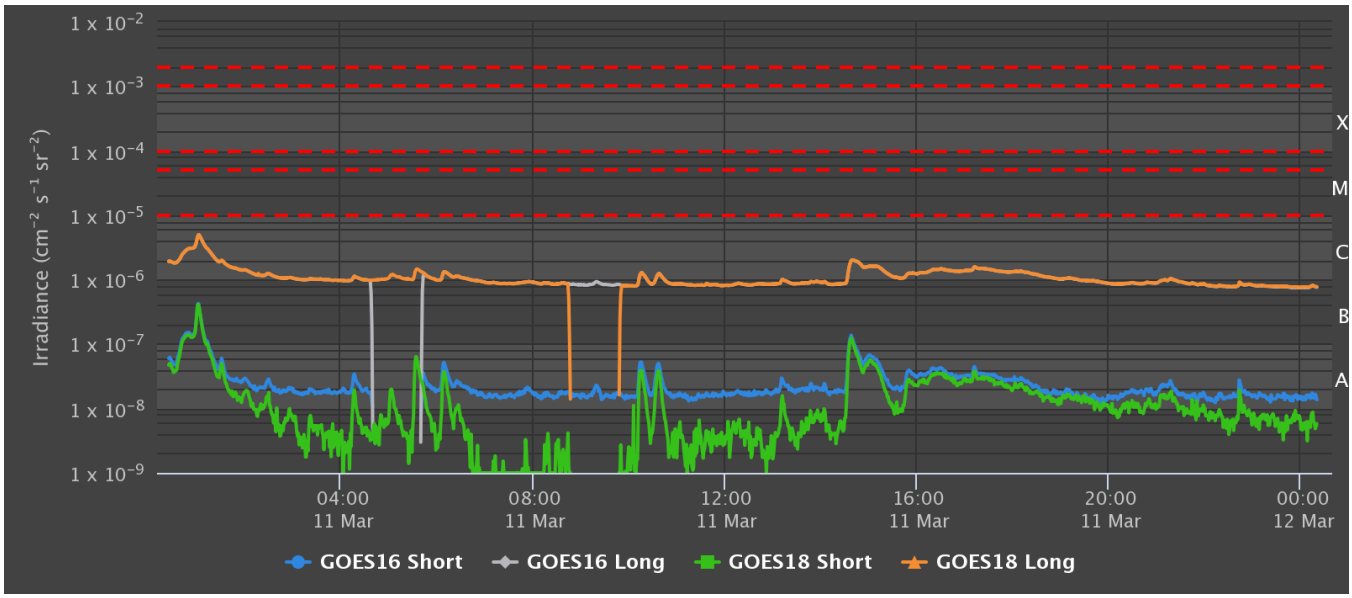
Radio Blackouts - X-Ray Flares:

There are currently 10 numbered sunspots on the visible disc and one unnumbered in the southeast. AR3245 is the largest region, although has not shown any significant development. The remaining regions on the disc are generally small or magnetically simple, and either stable or slowly evolving. AR3250 continues to show some spot emergence, with consolidation in its trailing portion. Some plage areas visible on the eastern limb but far side data so far shows only limited oncoming activity during the forecast period.

Solar activity is expected to remain Low with occasional C-class flares. But with the number of active regions on the disk there remains a chance of an isolated M-class flare, perhaps most likely from AR3245 or the developing AR3250.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES X-Ray flares.



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Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. AR3242 and AR3245 pose the most elevated proton risk. AR3242 is in the northwest quadrant, with AR3245 rotating across the southwest quadrant. The risk is maintained at a relatively low level as both spots transit the western hemisphere towards the limb through the guidance period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has been at mostly moderate levels through the past 24 hours. The long-lived high speed streams (HSS) related to coronal holes 81 and 82 have now waned. In the absence of further coronal holes and with limited geomagnetic activity, electron flux is expected to continue to follow a declining trend through the period, with peaks increasingly likely to be below the high threshold through the period. The BAS radiation belt model is suggesting high electron populations in lower Earth orbits, but with no significant geomagnetic activity forecast and solar wind speeds approaching background levels there appears to be limited mechanisms for the electrons to reach higher orbits.

Electron fluence remains below the Active threshold. Levels will probably continue to follow a steady or gradual declining trend through the period, with no inputs or enhancements into the belts currently forecast from high speed streams or CMEs. The output from Met Office REFM is considered to be giving a good guide, and probabilities for reaching Active fluence are relatively low.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	5	5	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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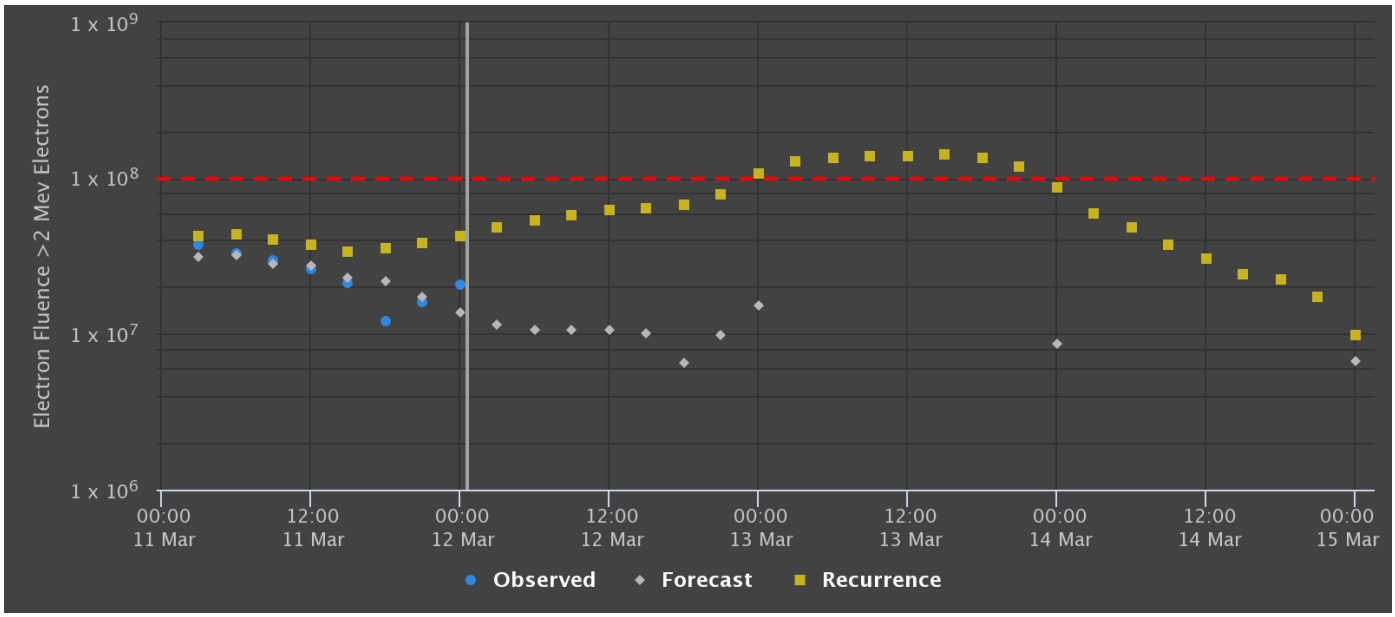
Figure 4: REFM electron fluence observations, forecast and recurrence.



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